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A Prediction of Cutting Forces Using Extended Kienzle Force Model Incorporating Tool Flank Wear Progression

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Abstract : In metal cutting, tool wear gradually changes the micro geometry of the cutting edge. Today there is a significant gap in understanding the impact these geometrical changes have on the cutting forces which governs tool deflection and heat generation in the cutting zone. Accurate models and understanding of the interaction between the work piece and cutting tool leads to improved accuracy in simulation of the cutting process. These simulations are useful in several application areas, e.g., optimization of insert geometry and machine tool monitoring. This study aims to develop an extended Kienzle force model to account for the effect of rake angle variations and tool flank wear have on the cutting forces. In this paper, the starting point sets from cutting force measurements using orthogonal turning tests of pre-machined flanches with well-defined width, using triangular coated inserts to assure orthogonal condition. The cutting forces have been measured by dynamometer with a set of three different rake angles, and wear progression have been monitored during machining by an optical measuring collaborative robot. The method utilizes the measured cutting forces with the inserts flank wear progression to extend the mechanistic cutting forces model with flank wear as an input parameter. The adapted cutting forces model is validated in a turning process with commercial cutting tools. This adapted cutting forces model shows the significant capability of prediction of cutting forces accounting for tools flank wear and different-rake-angle cutting tool inserts. The result of this study suggests that the nonlinear effect of tools flank wear and interaction between the work piece and the cutting tool can be considered by the developed cutting forces model.
Keywords : cutting force, kienzle model, predictive model, tool flank wear
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